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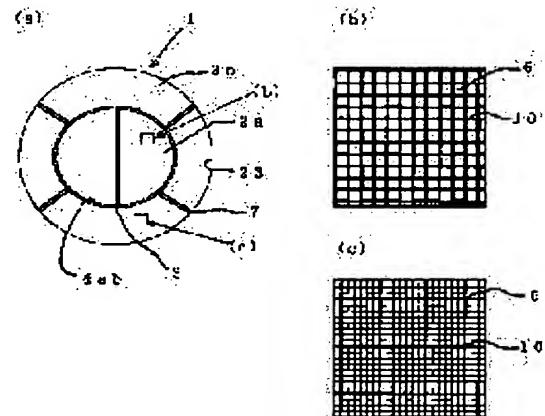
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## (54) HONEYCOMB STRUCTURE AND ASSEMBLY THEREFOR

### (57)Abstract:

**PROBLEM TO BE SOLVED:** To provide a honeycomb structure with small pressure loss and excellent durability against stress damages while suppressing the decline of a reaction rate, purification efficiency and regeneration efficiency, or the like, when used.

**SOLUTION:** The honeycomb structure 1 is composed by integrating a plurality of honeycomb segments 2a and 2b each composed of a honeycomb structure having many distribution holes 6 passing through in an axial direction and partitioned by partition wall 10. At least one of the honeycomb segments 2a not constituting the outer most circumferential surface 23 of the honeycomb structure 1, compared to at least one of the honeycomb segments 2b constituting the outermost circumferential surface 23, has larger average wall thickness and has smaller or argued cell density. A honeycomb structure assembly is composed by compressing and holding the honeycomb structure 1 inside a metal container by arranging a compressively elastic material B on the outermost circumferential surface 23 of the honeycomb structure 1 in a compressed state.



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**CLAIMS**

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**[Claim(s)]**

[Claim 1] The honeycomb structure object characterized by average wall thickness being thick, and a cel consistency being smaller than at least one of the honeycomb segments from which at least 1 of said honeycomb segment which is the honeycomb structure object with which it comes to unify two or more honeycomb segments which consist of honeycomb structure which has the circulation hole of a large number penetrated to the shaft orientations divided by the septum, and does not constitute the outermost peripheral surface of said honeycomb structure object constitutes said outermost peripheral surface, or being equal.

[Claim 2] The honeycomb structure object according to claim 1 characterized by the ratios of the cel consistency of at least one honeycomb segment which does not constitute said outermost peripheral surface, and the cel consistency of at least one honeycomb segment which constitutes said outermost peripheral surface being 1:1-1:6.

[Claim 3] The honeycomb structure object according to claim 1 or 2 characterized by the ratios to the average wall thickness in at least one of the honeycomb segments which do not constitute the outermost peripheral surface of a honeycomb structure object of the average wall thickness in at least one of the honeycomb segments which constitute the outermost peripheral surface of a honeycomb structure object being 0.2-0.9.

[Claim 4] A honeycomb structure object given in claim 1 to which the cross section of at least one honeycomb segment which does not constitute the outermost peripheral surface of a honeycomb structure object is characterized by being 9% - 81% of the cross section of said honeycomb structure object thru/or any 1 term of 3.

[Claim 5] A honeycomb structure object given in claim 1 characterized by using a honeycomb structure object as an object for automobile exhaust purification thru/or any 1 term of 4.

[Claim 6] A honeycomb structure object given in claim 1 characterized by using a honeycomb structure object as a filter for diesel particle uptake thru/or any 1 term of 5.

[Claim 7] A honeycomb structure object given in claim 1 characterized by coming to allot the compression spring material A at some or all between the fields where a honeycomb segment adjoins mutually thru/or any 1 term of 6.

[Claim 8] The honeycomb structure object according to claim 7 characterized by said compression spring material A being a mat made from ceramic fiber.

[Claim 9] The honeycomb structure object according to claim 8 characterized by being the non-expansibility mat with which said mat made from ceramic fiber uses an alumina or a mullite presentation as a principal component.

[Claim 10] A honeycomb structure object given in claim 1 characterized by the principal component of a honeycomb segment consisting of at least one sort of ceramics chosen from the group which consists of silicon carbide, silicon nitride, cordierite, an alumina, a mullite, a zirconia, zirconium phosphate, aluminum titanate, titanias, and such combination, a Fe-Cr-aluminum system metal, a nickel system metal, or metals Si and SiC thru/or any 1 term of 9.

[Claim 11] It is the honeycomb structure object with which it comes to unify two or more honeycomb segments which consist of honeycomb structure which has the circulation hole of a large number penetrated to the shaft orientations divided by the septum. At least 1 of said honeycomb segment which does not constitute the outermost peripheral surface of said honeycomb structure object Average wall thickness is thicker than at least one of the honeycomb segments which constitute said outermost peripheral surface. And the honeycomb structure object assembly which comes to carry out compression grasping into a metal vessel by a cel consistency being small or arranging the compression spring material B for a honeycomb structure object given in equal claim 1 thru/or any 1 term of 10 on the outermost peripheral surface of said honeycomb structure object in the state of compression.

[Claim 12] The honeycomb structure object assembly according to claim 11 characterized by said compression spring material B being a mat made from ceramic fiber.

[Claim 13] The honeycomb structure object assembly according to claim 12 characterized by being the heating expansibility mat with which said mat made from ceramic fiber contains a bar MYUKYU light, or said non-expansibility mat.

[Claim 14] A honeycomb structure object assembly given in claim 11 characterized by for a honeycomb structure object assembly pushing in and canning being carried out by the volume bundle, the clamshell, and swaging thru/or any 1 term of 13.

[Claim 15] A honeycomb structure object assembly given in claim 11 which it comes to contain to a metal vessel after making a honeycomb segment support a catalyst thru/or any 1 term of 14.

[Claim 16] A honeycomb structure object assembly given in claim 11 which makes this honeycomb segment come to support a catalyst after containing a honeycomb segment to a metal vessel thru/or any 1 term of 14.

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## DETAILED DESCRIPTION

### [Detailed Description of the Invention]

[0001]

[Field of the Invention] About the honeycomb structure object used for the particle uptake filter in the support for catalysts using catalyses, such as an internal combustion engine, a boiler, a chemical reaction device, and a reforming machine for fuel cells, or exhaust gas etc., and its assembly, this invention is excellent in the endurance over breakage especially by the thermal stress at the time of use, and relates to the small honeycomb structure object of pressure loss, and its assembly.

[0002]

[Description of the Prior Art] The honeycomb structure object is used for the uptake filter of the particle in the support for catalysts using catalyses, such as an internal combustion engine, a boiler, a chemical reaction device, and a reforming machine for fuel cells, or exhaust gas, especially a diesel particle etc.

[0003] The temperature distribution within honeycomb structure became uneven by the temperature change with rapid exhaust gas, or local generation of heat, and the honeycomb structure object used for such the purpose had problems, such as producing a crack on a honeycomb structure object. When used as a filter which carries out uptake of the particulate matter under exhaust air of a diesel power plant especially, to remove and reproduce was required, and since local elevated-temperature-ization was not avoided in this case, it is easy to generate big thermal stress, and was easy to burn the collected carbon particle and to generate a crack.

[0004] For this reason, the approach of joining the segment which divided the honeycomb structure object into plurality with a jointing material for corrugated fibreboard was proposed. For example, the manufacture approach of the honeycomb structure object which joins much honeycomb objects to a U.S. Pat. No. 4335783 official report with a discontinuous jointing material for corrugated fibreboard is indicated. Moreover, after carrying out extrusion molding of the matrix segment of the honeycomb structure which consists of a ceramic ingredient to JP,61-51240,B, processing the periphery section after baking and making it smooth, it is substantially [ as a matrix segment ] the same, and the thermal-shock-resistance rotation accumulation type at which the difference of an thermal expansion coefficient applies and calcinates [ the mineral composition after calcinating to the joint ] the ceramic jointing material for corrugated fibreboard which becomes with 0.1% or less in 800 degrees C is propose. Moreover, the ceramic honeycomb structure object which similarly joined the honeycomb segment of cordierite to the SAE paper 860008 in 1986 into cordierite cement is indicated. The ceramic honeycomb structure object which furthermore pasted up the honeycomb ceramic member on JP,8-28246,A by the nature sealant of elasticity which consists of the inorganic fiber which is each other interwoven with in three dimensions at least, an inorganic binder, an organic binder, and an inorganic particle is indicated.

[0005] However, for the further strengthening of emission control, engine high-performance-izing, etc., with an eye on an improvement of engine combustion conditions and improvement in the catalyst purification engine performance, exhaust gas temperature is rising every year and the thermal shock resistance required of honeycomb support is also becoming severe. Therefore, if the abrupt change of inflow gas \*\* at the time of use, local heat of reaction, heat of combustion, etc. become larger even if it

is the above honeycomb structure objects, thermal stress cannot fully be eased, but a crack is produced on a honeycomb structure object, and when extreme, the possibility of the structure breaking [ a honeycomb structure object ] in pieces by \*\*\*\*\* and vibration can be considered.

[0006] Although it is making a temperature change small by enlarging the heat capacity of a honeycomb structure object as a means solving such a problem, delaying a reaction rate and the rate of combustion, and lowering the maximum temperature and there is the approach of easing the thermal stress which acts on a honeycomb structure object By such approach, the conversion of a honeycomb structure object, purification effectiveness, and regeneration efficiency fall, there is a fault to which pressure loss becomes large, and when used as an object for automobile exhaust purification, problems, such as a fall of fuel consumption and drivability and enlargement of auxiliary machinery, are caused. Moreover, in JP,54-110189,B, the structure which made thin regularly the direction HE septum thickness of a cross-section core of honeycomb support is proposed, and the structure which made the cel septum for a periphery flank of a honeycomb structure object thicker than an internal cel septum is further proposed in JP,54-150406,A or JP,55-147154,A. However, it cannot be said that there is such a honeycomb structure object about sufficient endurance to the thermal stress at the time of use since the inside cel septum is thin although the reinforcement to the mechanical stress from the outside becomes strong.

[0007]

[Problem(s) to be Solved by the Invention] This invention is made in view of such a conventional situation, and the place made into the purpose has pressure loss in offering the honeycomb structure object which was small excellent in the endurance over thermal stress breakage, stopping under low [, such as conversion at the time of use, purification effectiveness, and regeneration efficiency, ].

[0008]

[Means for Solving the Problem] This invention by maintaining the periphery section at an elevated temperature, controlling the temperature rise of a core, as a result of repeating research that the above-mentioned technical problem should be solved It is based on having found out that the endurance over thermal stress was improvable, controlling degradation, such as conversion. Furthermore, pressure loss can be made small by thickening thickness of the septum of the honeycomb structure object in a core, and making a cel consistency below into the cel consistency of the periphery section. And even if it does not enlarge the whole heat capacity so much, it is based on having found out that the temperature rise of a core could be controlled.

[0009] Namely, the 1st invention is a honeycomb structure object with which it comes to unify two or more honeycomb segments which consist of honeycomb structure which has the circulation hole of a large number penetrated to the shaft orientations divided by the septum. At least 1 of said honeycomb segment which does not constitute the outermost peripheral surface of said honeycomb structure object The honeycomb structure object characterized by average wall thickness being thick, and a cel consistency being smaller than at least one of the honeycomb segments which constitute said outermost peripheral surface, or being equal is offered.

[0010] The cel consistency of at least one honeycomb segment which does not constitute said outermost peripheral surface in the 1st invention, It is desirable that ratios with the cel consistency of at least one honeycomb segment which constitutes said outermost peripheral surface are 1:1-1:6. It is desirable that the ratios to the average wall thickness in at least one of the honeycomb segments which do not constitute the outermost peripheral surface of the average wall thickness in at least one of the honeycomb segments which constitute the outermost peripheral surface are 0.2-0.9. Moreover, it is desirable that at least one volume of the honeycomb segment which does not constitute the outermost peripheral surface is 9% - 81% of volume of a honeycomb structure object. Moreover, it is desirable that a honeycomb structure object is used as an object for automobile exhaust purification, and it is still more desirable to be used as a filter for diesel particle uptake. Furthermore, it is desirable the compression spring material A and to arrange preferably the mat made from ceramic fiber and the non-expansibility mat which uses an alumina or a mullite presentation as a principal component still more preferably at some or all between the fields where a honeycomb segment adjoins mutually. Furthermore, it is desirable that it is what the principal component of a honeycomb segment becomes from at least one sort

of ceramics chosen from the group which consists of silicon carbide, silicon nitride, cordierite, an alumina, a mullite, a zirconia, zirconium phosphate, aluminum titanate, titanias, and such combination, a Fe-Cr-aluminum system metal, a nickel system metal, or Metals Si and SiC.

[0011] The 2nd invention offers the honeycomb structure object assembly which comes to carry out compression grasping of the above-mentioned honeycomb structure object into a metal vessel by arranging the compression spring material B on the outermost peripheral surface of this honeycomb structure object in the state of compression.

[0012] In the 2nd invention, it is desirable that said compression spring material B is a mat made from ceramic fiber, and it is still more desirable that it is the non-expansibility mat which uses the heating expansibility mat, alumina, or mullite presentation containing a bar MYUKYU light as a principal component. Moreover, it is desirable that a honeycomb structure object assembly pushes in and canning is carried out by the volume bundle, the clamshell, and swaging. Furthermore, it is desirable that it is the honeycomb structure object assembly which it comes to contain to a metal vessel after making a honeycomb segment support a catalyst, and after containing a honeycomb segment to a metal vessel, it is desirable that it is also the honeycomb structure object assembly which makes this honeycomb segment come to support a catalyst.

[0013]

[Embodiment of the Invention] Hereafter, although the honeycomb structure object of this invention and the contents of the honeycomb structure object assembly are explained to a detail according to a drawing, this invention is not limited to the following operation gestalten. In addition, unless a cross section has a notice especially in below, the perpendicular cross section to the direction of a circulation hole is meant.

[0014] Drawing 1 (a) is the cross-section-mimetic diagram of the honeycomb structure object in which 1 operation gestalt of the honeycomb structure object concerning this invention is shown. The honeycomb structure object 1 of this invention is constituted by unifying honeycomb segment 2a and 2b which have the circulation hole 6 of a large number penetrated to the shaft orientations divided by the septum 10 as shown in drawing 1 (b) and (c).

[0015] The important description of this invention is that average wall thickness is thicker than honeycomb segment 2b from which honeycomb segment 2a which does not constitute the outermost peripheral surface 23 constitutes the outermost peripheral surface, and a cel consistency is below equivalent, as shown in drawing 1 (b) and (c). In this invention, average wall thickness means the thickness of an average of the septum 10 which does not include the outermost peripheral wall of the honeycomb segment 2. Moreover, a cel consistency means the number of the circulation holes per unit cross section (the number of cels / cm<sup>2</sup>). Since pressure loss can be reduced and the reaction rate of the thick core of a septum can be low stopped by having made the honeycomb structure object of this invention such a configuration even if it thickens a septum, since the cel consistency of a core is smaller, the honeycomb structure inside-of-the-body maximum temperature can make small low the temperature distribution of the whole honeycomb structure object, holding sufficient conversion, purification effectiveness, and regeneration efficiency, as a result of becoming high [ the temperature of the thin outside segment of a septum ] in \*\*. Therefore, since it can make small the temperature distribution of the whole honeycomb structure object, the honeycomb structure object 1 of this invention being able to reduce the pressure loss of the whole honeycomb structure object, and enlarging conversion, purification effectiveness, and regeneration efficiency, it shows low voltage loss, high endurance, and efficient nature.

[0016] In this invention with "the honeycomb segment which does not constitute the outermost peripheral surface of a honeycomb structure object" (an inside segment is called henceforth) For example, in drawing 1 (a), two honeycomb segment 2a which does not constitute the outermost peripheral surface 23 of the honeycomb structure object 1 is meant. "The honeycomb segment which constitutes the outermost peripheral surface of a honeycomb structure object" (an outside segment is called henceforth) means 4 honeycomb segment 2b which constitutes the outermost peripheral surface 23 of the honeycomb structure object 1. Therefore, in drawing 1 , 1 of two inside segment 2a or two are

meant, and 1 of four outside segment 2bs, two, three, or four are meant [ one / of the inside segments / at least ] in at least one of the outside segments. For example, as for this invention shown in drawing 1, at least one segment has composition with a small cel consistency with the average thickness of a septum 10 thicker than at least one segment and among four outside segment 2bs among two inside segment 2a. In this invention, although the cel consistency of inside segment 2a may be equal to the cel consistency of outside segment 2b, it is desirable that the cel consistency of inside segment 2a is smaller than the cel consistency of outside segment 2b as mentioned above. Moreover, it is still more desirable that average wall thickness is [ two both of inside segment 2a ] thicker than any of four outside segment 2bs, and a cel consistency is small.

[0017] Although drawing 2 shows another operation gestalt of this invention, honeycomb segment 2c of the shape of a cross-section square of four cores becomes an inside segment in this case, and a total of 20 pieces (eight honeycomb segment 2f and honeycomb segment of four 2e \*\* 2d) become an outside segment respectively. Therefore, the cel consistency has composition below equivalent from average wall thickness [ in / in the average wall thickness in at least one segment of inside segment 2c / at least one segment ] thickly among the outside segments 2f, 2d, and 2e.

[0018] It is desirable that four average wall thickness of inside segment 2c to which average wall thickness is thick and a cel consistency touches [ in / honeycomb segment 2c below equivalent has a desirable direction near the core of the honeycomb structure object 1, for example, / drawing 2 ] the core on the cross section of the honeycomb structure object 1 is [ of a total of 20 outside segments 2d, 2f, and 2e / any one ] still more preferably thicker than the average wall thickness of the whole outside segment.

[0019] the ratio of the cel consistency of an inside segment with a smaller cel consistency, and the cel consistency of an outside segment with a larger cel consistency -- desirable -- 1:1-1:6 -- further -- desirable -- 1:1-1:5 -- further -- more -- desirable -- 1:1.1-1:5 -- it is 1:1.1-1:4 most preferably. If pressure loss with a small sufficiently low filter area will no longer be acquired if the cel consistency of an outside segment is smaller than the cel consistency of an inside segment and the cel consistency of an outside segment is too larger than the cel consistency of an inside segment when using it as a filter for diesel particles especially, the eye closure becomes difficult and cannot manufacture substantially.

[0020] The ratios to the average wall thickness of the thick inside segment of a septum of the average wall thickness in the thin outside segment of a septum are 0.2-0.9 preferably, are 0.3-0.9 still more preferably, and are 0.5-0.8 most preferably. If this ratio is too small, manufacture will become difficult substantially, and if too close to 1, the effectiveness of this invention will not be acquired.

[0021] The cross section of the whole honeycomb structure object is desirable, and the cross section of an inside segment with a small cel consistency with a thick and septum is 25% or more further more preferably 16% or more still more preferably 9% or more. The area containing a part for the circulation pore in the vertical section to the circulation hole 6 as indicated to be the cross section to drawing 1 and drawing 2 in this invention is meant. When this cross section is too small, the effectiveness which thickens a septum becomes less enough. Furthermore, it is 49% or less that the cross section of the thick inside segment of a septum is 81% or less of volume of the whole honeycomb structure object further more preferably 64% or less desirable still more preferably. Reaction effectiveness falls and is not desirable if this cross section is too large.

[0022] As for each cel consistency of the inside and an outside segment, in this invention, it is desirable that it is in the range of 0.9 - 310 cel / cm<sup>2</sup> (6-2000 cel / square inch). If a cel consistency is set to less than two 0.9 cels / cm, geometric surface area runs short, and if 310 cels / cm<sup>2</sup> is exceeded, pressure loss will become large too much. Moreover, as for the cross-section configuration (cel configuration) of the circulation hole 6 of the honeycomb segment 2, it is desirable that they are the viewpoint on manufacture to a triangle, a square, or the hexagons.

[0023] The honeycomb structure object 1 in this invention can join the field 4 where the honeycomb segment 2 adjoins mutually, for example using a jointing material for corrugated fibreboard 7, although the honeycomb segment 2 is unified. Moreover, it is also desirable to arrange the compression spring material A on the field which adjoins mutually [ a honeycomb segment ]. Furthermore, as shown in

drawing 1 (a), as shown in drawing 2, it is also still more desirable [ it is desirable compression spring material A3 and to arrange the mat made from ceramic fiber on field 4ab by which outside segment 2b adjoins inside segment 2a mutually preferably, and ] to allot compression spring material A3 to field 4ee which outside segment 2e adjoins mutually. Thus, by arranging the compression spring material A between each side, thermal stress is eased and the endurance of a honeycomb structure object improves further.

[0024] As for the compression spring material A, in this invention, it is desirable to have thermal resistance and cushioning properties. As a compression spring material A which has thermal resistance and cushioning properties They are the non-expansibility ingredient which does not contain a bar MYUKYU light on parenchyma, or a low expansibility ingredient containing a little bar MYUKYU light. An alumina, a high alumina, a mullite, silicon carbide, silicon nitride, a zirconia, It is desirable to use as a principal component the ceramic fiber which consists of at least one sort chosen from the group which consists of a titania, or those composites, and the non-expansibility ingredient which uses an alumina or a mullite as a principal component also in this, excluding a bar MYUKYU light on parenchyma is more desirable. Furthermore, it is desirable that they are these mats made from fiber, and it is still more desirable that it is the non-expansibility mat with which the mat made from ceramic fiber uses an alumina or a mullite presentation as a principal component. As for these mats made from a ceramic, it is still more desirable to have seal nature from a viewpoint which prevents the leakage of a processed fluid. The suitable examples of the compression spring material A are/by 3 M company1100HT, Mitsubishi Chemical / muff tech, etc.

[0025] As for the honeycomb segment 2, in this invention, it is desirable to consist of at least one sort of ceramics chosen from the group which a principal component becomes from viewpoints, such as reinforcement and thermal resistance, from silicon carbide, silicon nitride, cordierite, an alumina, a mullite, a zirconia, zirconium phosphate, aluminum titanate, titanias, and such combination, a Fe-Cr-aluminum system metal, a nickel system metal, or metals Si and SiC. In this invention, a principal component occupies more than 80 mass % of a component, and means the thing used as the main crystal phase. A jointing material for corrugated fibreboard 7 can also be chosen from the suitable ingredients for the above-mentioned honeycomb segment.

[0026] In case the compression spring material A is arranged, it is desirable still more desirable that at least one side is 30mm or more, and the cross section of the viewpoint on manufacture to the honeycomb segment 2 is 70mm or more most preferably 50mm or more.

[0027] Drawing 3 is the cross-section-mimetic diagram of the honeycomb structure object assembly 8 which held the honeycomb structure object shown in drawing 1 to the metal vessel 11. The honeycomb structure object assembly 8 of this invention shown in drawing 3 comes to carry out compression grasping of the honeycomb structure object 1 at a metal vessel 11 by allotting compression spring material B5 to the outermost peripheral surface 23 of the honeycomb structure object 1 in the state of compression.

[0028] Although it is desirable to have thermal resistance and cushioning properties like the above-mentioned compression spring material A as compression spring material B5 in this invention and it is desirable to have seal nature further, it may be a non-expansibility ingredient or you may be an expansibility ingredient. Although the desirable compression spring material B is ceramic fiber which uses as a principal component at least one sort chosen from the group which consists of an alumina, a high alumina, a mullite, silicon carbide, silicon nitride, a zirconia, and a titania, or those composites, it is still more desirable that they are these mats made from fiber. Although the above-mentioned/by 3 M company1100HT, Mitsubishi Chemical / muff tech, etc. can specifically be used, the/INTARAMU mat by 3 M company which is an expansibility mat can also be used.

[0029] In this invention, the approach of putting in the honeycomb structure object 1 in a metal vessel 11 in the state of compression with the compression spring material B Planar pressure is given by twisting and pulling metal plate 11c shown in the approach of pushing in using the guide 17 shown in drawing 4, and drawing 5. It puts giving a load by the metal vessels 11a and 11b which are shown in the volume fastening approach which welds the doubling section of metal plate 11c, and is fixed, or

drawing 6 and which were carried out 2 \*\*\*\*s. The clamshell approach used as a unification container by welding the part of the mating faces (flange) 16a and 16b of two metal vessels 11a and 11b is suitable. Moreover, the method (the swaging approach) of applying a compression pressure for a metal vessel 11 through a tap (pressurization mold) 12 from the exterior, and extracting the outer-diameter dimension of a metal vessel 11 of in addition to this having applied the plastic-working-of-metals technique as shown in drawing 7 is also suitable. Furthermore, the approach of extracting the outer diameter of a metal vessel by being based on the approach of narrowing down the outermost peripheral surface by plastic working using the processing fixture 18 and the so-called roll-forging approach, rotating a metal vessel 11 by the approach adapting plastic working, as shown in drawing 8 , and giving planar pressure is also possible.

[0030] When using for an internal combustion engine, a boiler, a chemical reaction device, the reforming machine for fuel cells, etc. by making the honeycomb structure object or honeycomb structure object assembly of this invention into catalyst support, it is made to make a honeycomb segment support the metal which has catalyst ability. It is desirable for Pt, Pd, Rh, etc. to be mentioned as a typical thing which has catalyst ability, and to make a honeycomb segment support at least one of sorts of these.

[0031] On the other hand, when it is going to use the particulate matter contained in exhaust gas like the particulate filter (DPF) for diesel power plants in the honeycomb structure object or honeycomb structure object assembly of this invention for the filter for carrying out uptake removal, what has the structure which stops the circulation hole of a honeycomb structure object by turns, and uses a septum as a filter is desirable.

[0032] If it lets the exhaust gas which contained particulate matter from the end side of the honeycomb structure object which consists of such honeycomb segments pass, exhaust gas will flow into the interior of a honeycomb structure object from the circulation hole by which the circulation hole by the side of the end side concerned is not stopped, will pass the septum of the porosity which has filtration ability, and will be discharged from the hole by which an other end side side is not stopped. Particulate matter is caught by the septum in case this septum is passed. The ingredient for stopping an end face can be chosen from the suitable ingredients for the above-mentioned honeycomb segment 2.

[0033] In addition, if the caught particulate matter accumulates on a septum, since a pressure loss will go up rapidly, a load will be applied to an engine and fuel consumption and drivability will fall, combustion removal of the particulate matter is carried out, and it is made to reproduce a filter function with heating means, such as a heater, periodically. In order to promote combustion at the time of this combustion playback, a honeycomb structure object may be made to support the metal which has the above catalyst ability.

[0034] In this invention, as an approach of making a honeycomb structure object or a honeycomb structure object assembly supporting a catalyst, after grasping the cel honeycomb structure object 1 in a metal vessel 11 before catalyst support, the method of making the honeycomb structure object 1 support a catalyst is possible. According to this approach, possibility that the honeycomb structure object 1 is missing, or will be damaged in a catalyst support process is avoidable. Moreover, after supporting a catalyst component to the honeycomb segment 2, when considering as the honeycomb structure object 1 and coming to carry out receipt grasping of this into a metal vessel 11 uses the honeycomb structure object or honeycomb structure object assembly of this invention as a catalytic converter, it is desirable.

[0035]

[Example] Hereafter, although this invention is further explained to a detail based on an example, this invention is not limited to these examples. In addition, the honeycomb structure object produced in the following examples and examples of a comparison is a filter for diesel particle uptake which \*\*\*\*\* a cel by turns and uses a septum as a filter.

[0036] (Example 1) As a raw material, silicon carbide powder was used, methyl cellulose and hydroxypropoxyl methyl cellulose, a surfactant, and water were added to this, and the reversible plastic matter was produced. Extrusion molding of this plastic matter was carried out, and it dried by microwave and hot blast. Subsequently, after carrying out eye closure of the end face with the eye sealing agent of a honeycomb structure object and this quality of the material so that it may become

alternate by turns, next carrying out heating cleaning in N<sub>2</sub> ambient atmosphere, it calcinates in Ar ambient atmosphere. With a cross-section configuration x die length [ of 1/2 outside segment 2b with a die length / 1 / 4 cross-section configuration x die length / of 152mm whose outer diameter is phi144mm, and whose bore is phi73mm, and whose an outer diameter are phi72mm ] of 152mm inside segment 2a was obtained. 0.38mm and the cel consistency of the wall thickness of inside segment 2a are 31 cels / cm<sup>2</sup>, and 0.25mm and the cel consistency of the wall thickness of outside segment 2b are 31 cels / cm<sup>2</sup>. The cylindrical honeycomb structure object 1 of diameter [ of 144mm ] x die-length [ of 152mm ] \*\* was assembled in these honeycomb segments by joining and drying colloidal silica and an alumina fiber with the jointing material for corrugated fibreboard mixed with water. Furthermore, the mat non-expanding made from ceramic fiber was twisted around the periphery of the honeycomb structure object 1, and it pushed into the metal vessel 11 of SUS409 with the taper fixture, and between segments, compression immobilization of between the honeycomb structure object 1 and a metal vessel was carried out, and the honeycomb structure object assembly 8 was obtained.

[0037] (Example 2) The same actuation as an example 1 was performed, and the honeycomb structure object 1 whose cel consistencies the wall thickness of inside segment 2a is 0.38mm, and are 31 cels / cm<sup>2</sup> and whose cel consistencies the wall thickness of outside segment 2b is 0.25mm, and are 47 cels / cm<sup>2</sup> was acquired. Furthermore, the mat non-expanding made from ceramic fiber was twisted around the periphery of the honeycomb structure object 1, and it pushed into the metal vessel 11 of SUS409 with the taper fixture, and between segments, compression immobilization of between the honeycomb structure object 1 and a metal vessel 11 was carried out, and the honeycomb structure object assembly 8 was obtained.

[0038] (Example 3) The same actuation as an example 1 was performed, and the honeycomb structure object 1 whose cel consistencies the wall thickness of inside segment 2a is 0.43mm, and are 31 cels / cm<sup>2</sup> and whose cel consistencies the wall thickness of outside segment 2b is 0.20mm, and are 47 cels / cm<sup>2</sup> was acquired. Furthermore, the mat non-expanding made from ceramic fiber was twisted around the periphery of the honeycomb structure object 1, and it pushed into the metal vessel 11 of SUS409 with the taper fixture, and between segments, compression immobilization of between the honeycomb structure object 1 and a metal vessel 11 was carried out, and the honeycomb structure object assembly 8 was obtained.

[0039] (Example 4) The same actuation as an example 1 was performed, and the honeycomb structure object 1 whose cel consistencies the wall thickness of inside segment 2a is 0.53mm, and are 16 cels / cm<sup>2</sup> and whose cel consistencies the wall thickness of outside segment 2b is 0.20mm, and are 62 cels / cm<sup>2</sup> was acquired. Furthermore, the mat non-expanding made from ceramic fiber was twisted around the periphery of the honeycomb structure object 1, and it pushed into the metal vessel 11 of SUS409 with the taper fixture, and between segments, compression immobilization of between the honeycomb structure object 1 and a metal vessel 11 was carried out, and the honeycomb structure object assembly 8 was obtained.

[0040] (Example 1 of a comparison) The same actuation as an example 1 was performed, and the honeycomb structure object 1 whose cel consistencies the wall thickness of all the segments of the inside and an outside is 0.38mm, and are 31 cels / cm<sup>2</sup> was acquired. Furthermore, the mat non-expanding made from ceramic fiber was twisted around the periphery of the honeycomb structure object 1, and it pushed into the metal vessel of SUS409 with the taper fixture, and between segments, compression immobilization of between the honeycomb structure object 1 and a metal vessel 11 was carried out, and the honeycomb structure object assembly 8 was obtained.

[0041] (Soot volume pressure loss trial) Pressure loss when a 4g soot deposits on through and a honeycomb structure filter the exhaust gas of the exhaust gas temperature of 200 degrees C which contained the particle (a soot is called henceforth) discharged from a diesel power plant in the honeycomb structure filter (honeycomb structure object assembly) of the examples 1-4 which carried out in this way and were acquired, and the example 1 of a comparison, and amount of emission of 2.4Nm<sup>3</sup>/min. was measured. A test result is shown in drawing 9 . The pressure losses at the time of making the filter of the example 1 of a comparison deposit a 4g soot were 9.0KPa(s). The filter of the

example 1 which made wall thickness of an outside segment thin compared with this was low 26% compared with 6.7KPa(s) and the example of a comparison. The example 2 which considered as the same wall thickness as an example 1, and enlarged the cel consistency of an outside segment showed the pressure loss of 6.2KPa(s), and it was low voltage loss further with 31% compared with the example of a comparison. Furthermore, are thick in the wall thickness of an inside segment in order to reduce more the thermal stress committed on a honeycomb structure object. Because the filter of the disadvantageous example 3 for a pressure loss and example 4 which enlarged heat capacity is also still thinner in the wall thickness of an outside segment and enlarges a cel consistency further 34%, 33%, and a sufficiently low pressure loss were made possible [ the pressure loss of 6.0KPa(s) / respectively ] at the example of a comparison with the pressure loss of 5.9KPa(s), and the filter of an example 4 with the filter of an example 3.

[0042] (Combustion playback trial) 30g uptake of the soot was respectively carried out to the honeycomb structure filter of examples 3 and 4 and the example 1 of a comparison, and the temperature of combustion and the 15 honeycomb structure inside of the body was measured for 700 degree C of inlet-port gas \*\*, 10% of oxygen densities, and the soot deposited on the filter with the exhaust gas of amount of emission of 0.7Nm 3/min. The weight of a honeycomb structure filter was measured after the combustion test, and the regeneration efficiency of a soot was searched for. Furthermore, the existence of observation and breakage was checked for damage on the honeycomb structure object by combustion playback with viewing and a stereoscopic microscope.

[0043] The honeycomb structure inside-of-the-body maximum temperature of the filter of the example 1 of a comparison rose to 1050 degrees C, and the honeycomb structure object was damaged. On the other hand, the maximum temperature was respectively suppressed low with 830 degrees C and 780 degrees C, and, as for the filter of the examples 3 and 4 by this invention, soot regeneration efficiency also showed 90% or more.

[0044]

[Effect of the Invention] As explained above, the honeycomb structure object by this invention and its assembly Since wall thickness of an inside segment is made thicker than the wall thickness of an outside segment, and it is thinner than the wall thickness of an inside segment in the wall thickness of an outside segment, and is large in the effective porosity of a septum by enlarging a cel consistency and filter area can be enlarged It was low, and the maximum temperature generated in the honeycomb structure inside of the body was suppressed low, and the pressure loss at the time of diesel particle deposition became what keeps soot regeneration efficiency high. Therefore, the honeycomb structure object by this invention and its assembly had low pressure loss, and the outstanding endurance and high effectiveness were shown.

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[Translation done.]

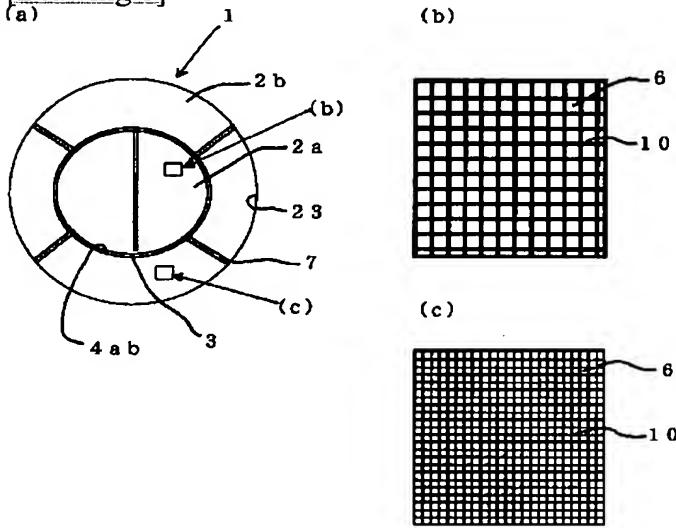
\* NOTICES \*

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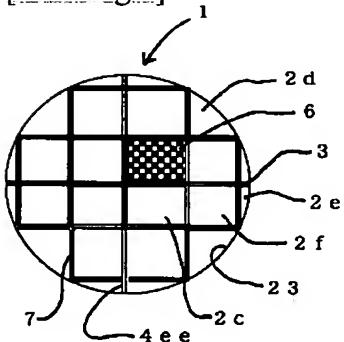
1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. \*\*\*\* shows the word which can not be translated.
3. In the drawings, any words are not translated.

DRAWINGS

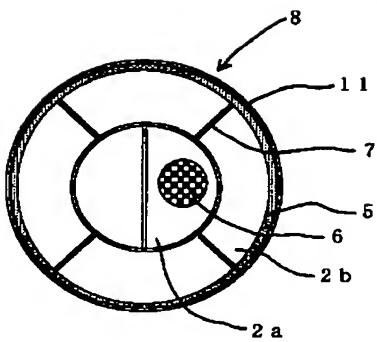
[Drawing 1]



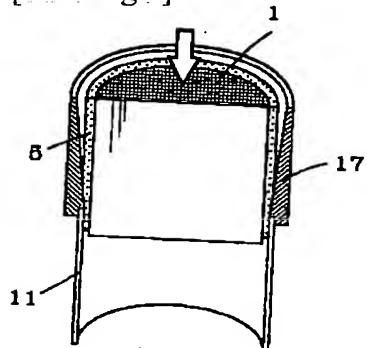
[Drawing 2]



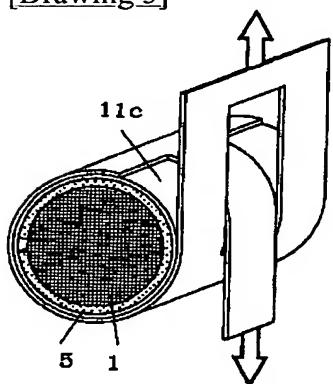
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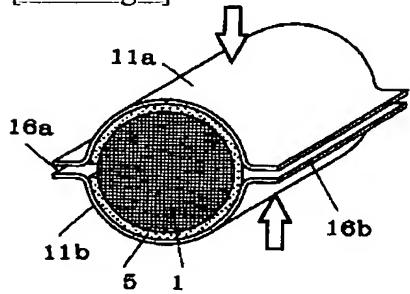
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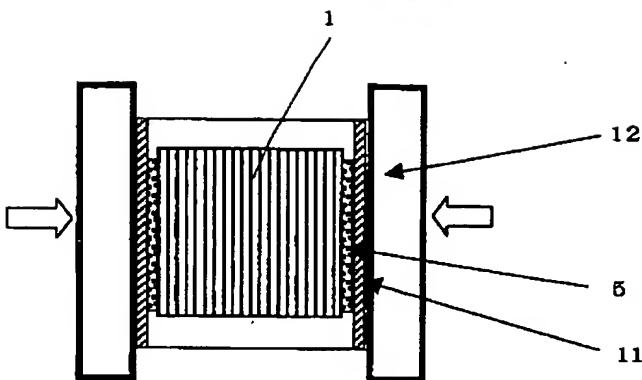
[Drawing 5]



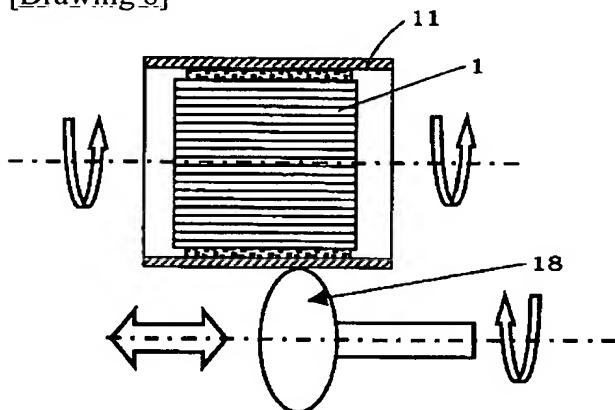
[Drawing 6]



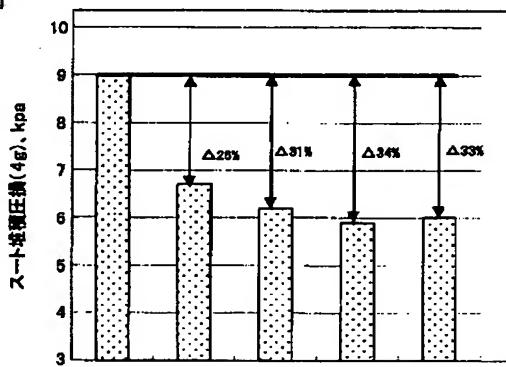
[Drawing 7]



[Drawing 8]

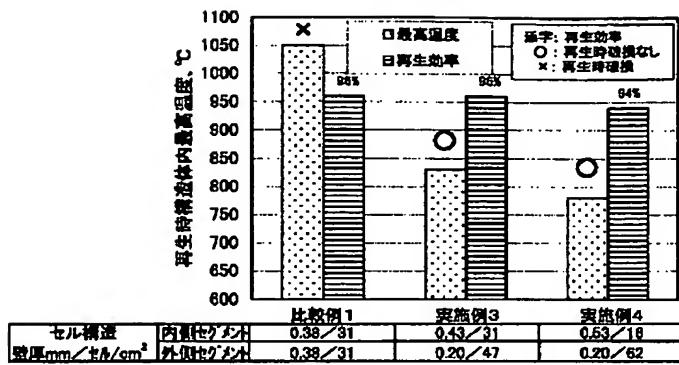


[Drawing 9]



セル構造	内側セグメント	0.38/31	0.38/31	0.38/31	0.43/31	0.63/18
壁厚mm/ $\text{in}^2/\text{cm}^2$	外側セグメント	0.38/31	0.25/31	0.25/47	0.20/47	0.20/62

[Drawing 10]



[Translation done.]

# PATENT ABSTRACTS OF JAPAN

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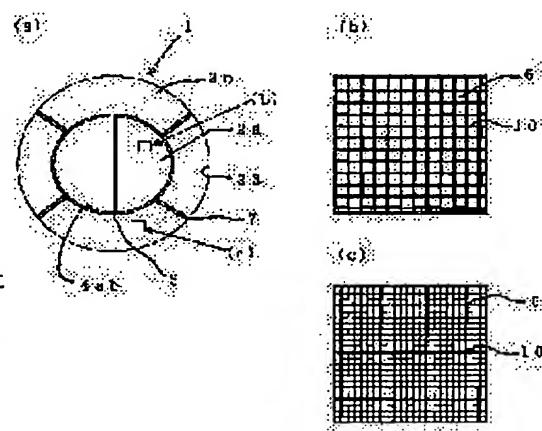
(21)Application number : 2001-105134 (71)Applicant : NGK INSULATORS LTD  
(22)Date of filing : 03.04.2001 (72)Inventor : HIJIKATA TOSHIHIKO

(54) HONEYCOMB STRUCTURE AND ASSEMBLY THEREFOR

(57) Abstract:

**PROBLEM TO BE SOLVED:** To provide a honeycomb structure with small pressure loss and excellent durability against stress damages while suppressing the decline of a reaction rate, purification efficiency and regeneration efficiency, or the like, when used.

**SOLUTION:** The honeycomb structure 1 is composed by integrating a plurality of honeycomb segments 2a and 2b each composed of a honeycomb structure having many distribution holes 6 passing through in an axial direction and partitioned by partition wall 10. At least one of the honeycomb segments 2a not constituting the outer most circumferential surface 23 of the honeycomb structure 1, compared to at least one of the honeycomb segments 2b constituting the outermost circumferential surface 23, has larger average wall thickness and has smaller or equal cell density. A honeycomb structure assembly is composed by compressing and holding the honeycomb structure 1 inside a metal container by arranging a compressively elastic material B on the outermost circumferential surface 23 of the honeycomb structure 1 in a compressed state.



## **LEGAL STATUS**

[Date of request for examination]

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[Patent number]

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of rejection]

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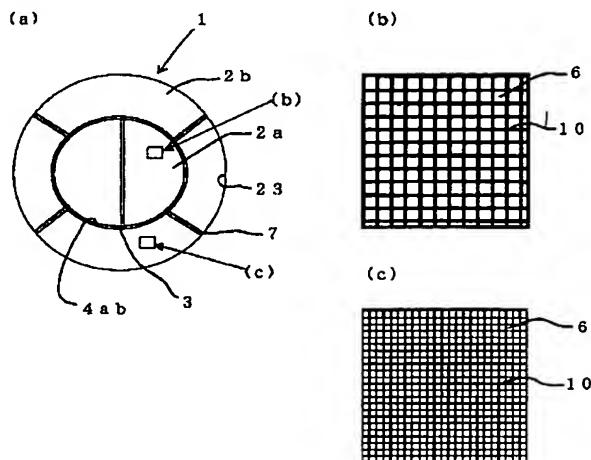
弁理士 渡邊 一平

(54) 【発明の名称】 ハニカム構造体及びそのアッセンブリ

(57) 【要約】

【課題】 使用時における反応率、浄化効率、再生効率等の低下を抑えつつ、圧力損失が小さく熱応力破損に対する耐久性に優れたハニカム構造体を提供する。

【解決手段】 隔壁10により仕切られた軸方向に貫通する多数の流通孔6を有するハニカム構造からなる複数のハニカムセグメント2a及び2bが一体化されてなるハニカム構造体1である。ハニカム構造体1の最外周面23を構成しないハニカムセグメント2aの少なくとも1が、最外周面23を構成するハニカムセグメント2bの少なくとも1つよりも平均壁厚が厚く、且つセル密度が小さいか又は等しいことを特徴とするハニカム構造体1である。ハニカム構造体1を、ハニカム構造体1の最外周面23に圧縮弾性材料Bを圧縮状態で配することにより金属容器内に圧縮保持してなるハニカム構造体アッセンブリである。



【特許請求の範囲】

【請求項1】 隔壁により仕切られた軸方向に貫通する多数の流通孔を有するハニカム構造からなる複数のハニカムセグメントが一体化されてなるハニカム構造体であって、前記ハニカム構造体の最外周面を構成しない前記ハニカムセグメントの少なくとも1が、前記最外周面を構成するハニカムセグメントの少なくとも1つよりも平均壁厚が厚く、且つセル密度が小さいか又は等しいことを特徴とするハニカム構造体。

【請求項2】 前記最外周面を構成しない少なくとも1つのハニカムセグメントのセル密度と前記最外周面を構成する少なくとも1つのハニカムセグメントのセル密度との比が1:1~1:6であることを特徴とする請求項1に記載のハニカム構造体。

【請求項3】 ハニカム構造体の最外周面を構成するハニカムセグメントの少なくとも1つにおける平均壁厚の、ハニカム構造体の最外周面を構成しないハニカムセグメントの少なくとも1つにおける平均壁厚に対する比率が0.2~0.9であることを特徴とする請求項1又は2に記載のハニカム構造体。

【請求項4】 ハニカム構造体の最外周面を構成しない少なくとも1つのハニカムセグメントの断面積が、前記ハニカム構造体の断面積の9%~81%であることを特徴とする請求項1乃至3の何れか1項に記載のハニカム構造体。

【請求項5】 ハニカム構造体が自動車排ガス浄化用として用いられるることを特徴とする請求項1乃至4の何れか1項に記載のハニカム構造体。

【請求項6】 ハニカム構造体がディーゼル微粒子捕集用フィルターとして用いられることを特徴とする請求項1乃至5の何れか1項に記載のハニカム構造体。

【請求項7】 ハニカムセグメントが互いに隣接する面の間の一部又は全部に圧縮弾性材料Aを配してなることを特徴とする請求項1乃至6の何れか1項に記載のハニカム構造体。

【請求項8】 前記圧縮弾性材料Aがセラミック繊維製マットであることを特徴とする請求項7に記載のハニカム構造体。

【請求項9】 前記セラミック繊維製マットがアルミニウム又はムライト組成を主成分とする非膨脹性マットであることを特徴とする請求項8に記載のハニカム構造体。

【請求項10】 ハニカムセグメントの主成分が、炭化珪素、窒化珪素、コーニジライト、アルミニウム、ムライト、ジルコニア、磷酸ジルコニア、アルミニウムチタネート、チタニア及びこれらの組み合わせよりなる群から選ばれる少なくとも1種のセラミックス、Fe-Cr-A1系金属、ニッケル系金属又は金属SiとSiCとからなることを特徴とする請求項1乃至9のいずれか1項に記載のハニカム構造体。

【請求項11】 隔壁により仕切られた軸方向に貫通す

る多数の流通孔を有するハニカム構造からなる複数のハニカムセグメントが一体化されてなるハニカム構造体であって、前記ハニカム構造体の最外周面を構成しない前記ハニカムセグメントの少なくとも1が、前記最外周面を構成するハニカムセグメントの少なくとも1つよりも平均壁厚が厚く、且つセル密度が小さいか又は等しい請求項1乃至10の何れか1項に記載のハニカム構造体を、前記ハニカム構造体の最外周面に圧縮弾性材料Bを圧縮状態で配することにより金属容器内に圧縮把持してなるハニカム構造体アッセンブリ。

【請求項12】 前記圧縮弾性材料Bがセラミック繊維製マットであることを特徴とする請求項11に記載のハニカム構造体アッセンブリ。

【請求項13】 前記セラミック繊維製マットがバーミュキュライトを含む加熱膨脹性マット又は前記非膨脅性マットであることを特徴とする請求項12に記載のハニカム構造体アッセンブリ。

【請求項14】 ハニカム構造体アッセンブリが、押込み、巻き締め、クラムシェル、スウェージングでキャシングされていることを特徴とする請求項11乃至13の何れか1項に記載のハニカム構造体アッセンブリ。

【請求項15】 ハニカムセグメントに触媒を担持させた後、金属容器に収納してなる請求項11乃至14の何れか1項に記載のハニカム構造体アッセンブリ。

【請求項16】 ハニカムセグメントを金属容器に収納した後に、該ハニカムセグメントに触媒を担持させてなる請求項11乃至14の何れか1項に記載のハニカム構造体アッセンブリ。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】 本発明は、内燃機関、ボイラー、化学反応機器及び燃料電池用改質器等の触媒作用を利用する触媒用担体又は排ガス中の微粒子捕集フィルター等に用いられるハニカム構造体及びそのアッセンブリに関し、特に使用時の熱応力による破損に対する耐久性に優れ、且つ圧力損失の小さいハニカム構造体及びそのアッセンブリに関する。

【0002】

【従来の技術】 内燃機関、ボイラー、化学反応機器及び燃料電池用改質器等の触媒作用を利用する触媒用担体、又は排ガス中の微粒子、特にディーゼル微粒子の捕集フィルター等にハニカム構造体が用いられている。

【0003】 この様な目的で使用されるハニカム構造体は、排気ガスの急激な温度変化や局所的な発熱によってハニカム構造内の温度分布が不均一となり、ハニカム構造体にクラックを生ずる等の問題があった。特にディーゼルエンジンの排気中の粒子状物質を捕集するフィルターとして用いられる場合には、溜まったカーボン微粒子を燃焼させて除去し再生することが必要であり、この際に局所的な高温化が避けられないため、大きな熱応力

が発生し易く、クラックが発生し易かった。

【0004】このため、ハニカム構造体を複数に分割したセグメントを接合材により接合する方法が提案された。例えば、米国特許第4335783号公報には、多数のハニカム体を不連続な接合材で接合するハニカム構造体の製造方法が開示されている。また、特公昭61-51240号公報には、セラミック材料よりなるハニカム構造のマトリックスセグメントを押し出し成形し、焼成後その外周部を加工して平滑にした後、その接合部に焼成後の鉱物組成がマトリックスセグメントと実質的に同じで、且つ熱膨脹率の差が800°Cにおいて0.1%以下となるセラミック接合材を塗布し、焼成する耐熱衝撃性回転蓄熱式が提案されている。また、1986年のSAE論文860008には、コーチェライトのハニカムセグメントを同じくコーチェライトセメントで接合したセラミックハニカム構造体が開示されている。さらに特開平8-28246号公報には、ハニカムセラミック部材を少なくとも三次元的に交錯する無機纖維、無機バインダー、有機バインダー及び無機粒子からなる弾性質シール材で接着したセラミックハニカム構造体が開示されている。

【0005】しかしながら、排ガス規制の更なる強化やエンジンの高性能化等のため、エンジン燃焼条件の改善、触媒浄化性能の向上を狙いとして、排気ガス温度が年々上昇してきており、ハニカム担体に要求される耐熱衝撃性も厳しくなってきている。従って、上述のようなハニカム構造体であっても、使用時における流入ガス温の急激な変化、局所的な反応熱、燃焼熱等がより大きくなると、充分に熱応力を緩和できず、ハニカム構造体にクラックを生じ、極端な場合ハニカム構造体がばらけ、振動により構造体が粉々に破壊するなどの可能性が考えられる。

【0006】このような問題を解消する手段としては、ハニカム構造体の熱容量を大きくすることで温度変化を小さくし、反応速度、燃焼速度を遅らせ、最大温度を下げることで、ハニカム構造体に作用する熱応力を緩和する方法があるが、このような方法では、ハニカム構造体の反応率、浄化効率、再生効率が低下し、圧力損失が大きくなる欠点があり、自動車排ガス浄化用として用いられた場合、燃費、ドライバビリティの低下、補機類の大型化等の問題を起こす。また、特公昭54-110189号公報において、ハニカム担体の横断面中心方向へ隔壁厚さを規則的に薄くした構造が提案されており、さらに、特開昭54-150406号公報又は特開昭55-147154号公報において、ハニカム構造体の外周側部分のセル隔壁を内部のセル隔壁よりも厚くした構造が提案されている。しかし、この様なハニカム構造体は外部からの機械的応力に対する強度は強くなるが、内側のセル隔壁が薄いため、使用時における熱応力に対しでは充分な耐久性があるとは言えない。

### 【0007】

【発明が解決しようとする課題】本発明はこのような従来の事情に鑑みてなされたものであり、その目的とするところは、使用時における反応率、浄化効率、再生効率等の低下抑えつつ、圧力損失が小さく且つ熱応力破損に対する耐久性に優れたハニカム構造体を提供することにある。

### 【0008】

【課題を解決するための手段】本発明は上記課題を解決すべく研究を重ねた結果、中心部の温度上昇を抑制しつつ外周部を高温に保つことにより、反応率等の効率低下を抑制しつつ熱応力に対する耐久性を改良できることを見出したに基づき、さらに、中心部におけるハニカム構造体の隔壁の厚さを厚くし且つセル密度を外周部のセル密度以下にすることによって圧力損失を小さくすることができ、且つ全体の熱容量をさほど大きくしなくても中心部の温度上昇を抑制できることを見出したに基づくものである。

【0009】即ち、第1の発明は、隔壁により仕切られた軸方向に貫通する多数の流通孔を有するハニカム構造からなる複数のハニカムセグメントが一体化されてなるハニカム構造体であって、前記ハニカム構造体の最外周面を構成しない前記ハニカムセグメントの少なくとも1が、前記最外周面を構成するハニカムセグメントの少なくとも1つよりも平均壁厚が厚く、且つセル密度が小さいか又は等しいことを特徴とするハニカム構造体を提供するものである。

【0010】第1の発明において、前記最外周面を構成しない少なくとも1つのハニカムセグメントのセル密度と、前記最外周面を構成する少なくとも1つのハニカムセグメントのセル密度との比が1:1~1:6であることが好ましく、最外周面を構成するハニカムセグメントの少なくとも1つにおける平均壁厚の、最外周面を構成しないハニカムセグメントの少なくとも1つにおける平均壁厚に対する比率が0.2~0.9であることが好ましい。また、最外周面を構成しないハニカムセグメントの少なくとも1つの体積がハニカム構造体の体積の9%~81%であることが好ましい。また、ハニカム構造体が自動車排ガス浄化用として用いられることが好ましく、ディーゼル微粒子捕集用フィルターとして用いられることがさらに好ましい。さらに、ハニカムセグメントが互いに隣接する面の間の一部又は全部に圧縮弾性材料A、好ましくはセラミック繊維製マット、さらに好ましくはアルミナ又はムライト組成を主成分とする非膨張性マットを配することが好ましい。さらに、ハニカムセグメントの主成分が、炭化珪素、窒化珪素、コーチェライト、アルミナ、ムライト、ジルコニア、磷酸ジルコニア、アルミニウムチタネット、チタニア及びこれらの組み合わせよりなる群から選ばれる少なくとも1種のセラミックス、Fe-Cr-Al系金属、ニッケル系金属又

は金属SiとSiCとからなるものであることが好ましい。

【0011】 第2の発明は、上記ハニカム構造体を、該ハニカム構造体の最外周面に圧縮弾性材料Bを圧縮状態で配することにより金属容器内に圧縮保持してなるハニカム構造体アッセンブリを提供するものである。

【0012】 第2の発明において、前記圧縮弾性材料Bがセラミック繊維製マットであることが好ましく、バーミュキュライトを含む加熱膨脹性マット又はアルミニナ又はムライト組成を主成分とする非膨脹性マットであることがさらに好ましい。また、ハニカム構造体アッセンブリが、押込み、巻き締め、クラムシェル、スウェーディングでキャニニングされていることが好ましい。さらに、ハニカムセグメントに触媒を担持させた後、金属容器に収納してなるハニカム構造体アッセンブリであることが好ましく、また、ハニカムセグメントを金属容器に収納した後に、該ハニカムセグメントに触媒を担持させてなるハニカム構造体アッセンブリであることも好ましい。

【0013】

【発明の実施の形態】 以下、図面に従って、本発明のハニカム構造体及びハニカム構造体アッセンブリの内容を詳細に説明するが、本発明は以下の実施形態に限定されるものではない。尚、以下において断面とは、特に断りのない限り流通孔方向に対する垂直の断面を意味する。

【0014】 図1(a)は本発明に係るハニカム構造体の一実施形態を示すハニカム構造体の断面-模式図である。本発明のハニカム構造体1は図1(b)、(c)に示されるような隔壁10により仕切られた軸方向に貫通する多数の流通孔6を有するハニカムセグメント2a及び2bが一体化されることにより構成される。

【0015】 本発明の重要な特徴は、図1(b)、(c)に示されるように、最外周面23を構成しないハニカムセグメント2aが、最外周面を構成するハニカムセグメント2bよりも平均壁厚が厚く且つセル密度が同等以下であることである。本発明において、平均壁厚とはハニカムセグメント2の最外周壁を含めない隔壁10の平均の厚さを意味する。また、セル密度とは単位断面積当たりの流通孔の数(セル数/cm<sup>2</sup>)を意味する。本発明のハニカム構造体は、この様な構成にしたことにより、中心部のセル密度がより小さいため、隔壁を厚くしても圧力損失を低減することができ、且つ隔壁の厚い中心部の反応速度を低く抑えられるので、ハニカム構造体内最大温度は低くなり、隔壁の薄い外側セグメントの温度は高くなる結果、十分な反応率、浄化効率、再生効率を保持しながら、ハニカム構造体全体の温度分布を小さくできる。従って、本発明のハニカム構造体1は、ハニカム構造体全体の圧力損失を低減することができ、且つ反応率、浄化効率、再生効率を大きくしつつ、ハニカム構造体全体の温度分布を小さくできるので、低圧

損、高耐久性、高効率性を示すものとなる。

【0016】 本発明において、「ハニカム構造体の最外周面を構成しないハニカムセグメント」(以後内側セグメントと称す)とは、例えば図1(a)において、ハニカム構造体1の最外周面23を構成しない2つのハニカムセグメント2aを意味し、「ハニカム構造体の最外周面を構成するハニカムセグメント」(以後外側セグメントと称す)とは、ハニカム構造体1の最外周面23を構成する4つハニカムセグメント2bを意味する。従って、内側セグメントの少なくとも1つとは、例えば図1において2つの内側セグメント2aのうちの1つ又は2つを意味し、外側セグメントの少なくとも1つとは、4つの外側セグメント2bのうちの1つ、2つ、3つ又は4つを意味する。例えば図1に示される本発明は、2つの内側セグメント2aのうち少なくとも1つのセグメントが、4つの外側セグメント2bのうち少なくとも1つのセグメントよりも隔壁10の平均厚さが厚く且つセル密度が小さい構成となっている。本発明において、内側セグメント2aのセル密度は、外側セグメント2bのセル密度と等しくても良いが、上記のように内側セグメント2aのセル密度が外側セグメント2bのセル密度より小さいことが好ましい。また、2つの内側セグメント2aの両者が、4つの外側セグメント2bの何れよりも平均壁厚が厚く且つセル密度が小さいことがさらに好ましい。

【0017】 図2は本発明の別の実施形態を示したものであるが、この場合には中心部4個の断面四角形状のハニカムセグメント2cが内側セグメントとなり、各々8個のハニカムセグメント2f、2e及4個のハニカムセグメント2dの合計20個が外側セグメントとなる。従って、内側セグメント2cの少なくとも1つのセグメントにおける平均壁厚が、外側セグメント2f、2d及び2eのうち少なくとも1つのセグメントにおける平均壁厚より厚く且つセル密度が同等以下の構成となっている。

【0018】 平均壁厚が厚く且つセル密度が同等以下のハニカムセグメント2cは、ハニカム構造体1の中心部に近い方が好ましく、例えば図2において、ハニカム構造体1の断面上の中心に接する4つの内側セグメント2cの平均壁厚が合計20個の外側セグメント2d、2f及び2eの何れか1つ、さらに好ましくは外側セグメント全体の平均壁厚よりも厚いことが好ましい。

【0019】 セル密度がより小さい内側セグメントのセル密度と、セル密度がより大きい外側セグメントのセル密度との比は、好ましくは1:1~1:6、さらに好ましくは1:1~1:5、さらにより好ましくは1:1~1:5、最も好ましくは1:1~1:4である。特に、ディーゼル微粒子用フィルターとして使用する場合、外側セグメントのセル密度が内側セグメントのセル密度よりも小さいと、フィルター面積が小さく十

分低い圧力損失が得られなくなり、外側セグメントのセル密度が内側セグメントのセル密度よりも大きすぎると、目封止が困難となり、実質的に製造できない。

【0020】隔壁の薄い外側セグメントにおける平均壁厚の、隔壁の厚い内側セグメントの平均壁厚に対する比率は、好ましくは0.2～0.9であり、さらに好ましくは0.3～0.9であり、最も好ましくは0.5～0.8である。この比率が小さすぎると実質的に製造が困難となり、1に近すぎると本発明の効果が得られない。

【0021】隔壁が厚く且つセル密度が小さい内側セグメントの断面積は、ハニカム構造体全体の断面積の好ましくは9%以上、さらに好ましくは16%以上、さらにより好ましくは25%以上である。本発明において断面積とは、図1、図2に示されるような、流通孔6に対する垂直断面における流通孔部分を含む面積を意味する。この断面積が小さすぎると隔壁を厚くする効果が充分ではなくなる。さらに、隔壁の厚い内側セグメントの断面積がハニカム構造体全体の体積の81%以下であることが好ましく、さらに好ましくは64%以下、さらにより好ましくは49%以下である。この断面積が大きすぎると反応効率が低下し好ましくない。

【0022】本発明において、内側及び外側セグメントのセル密度は何れも0.9～310セル/cm<sup>2</sup>(6～2000セル/平方インチ)の範囲にあることが好ましい。セル密度が0.9セル/cm<sup>2</sup>未満になると、幾何学的表面積が不足し、310セル/cm<sup>2</sup>を超えると、圧力損失が大きくなりすぎる。また、ハニカムセグメント2の流通孔6の断面形状(セル形状)は、製作上の観点から、三角形、四角形及び六角形のうちのいずれかであることが好ましい。

【0023】本発明におけるハニカム構造体1はハニカムセグメント2が一体化されたものであるが、例えば接合材7を用いてハニカムセグメント2が互いに隣接する面4を接合することができる。また、圧縮弾性材料Aをハニカムセグメントの互いに隣接する面に配することも好ましい。さらに、図1(a)に示されるように、圧縮弾性材料A3、好ましくはセラミック繊維製マットを内側セグメント2aと外側セグメント2bが互いに隣接する面4abに配することが好ましく、さらに、図2に示されるように、外側セグメント2e同士が互いに隣接する面4eeに圧縮弾性材料A3を配することも好ましい。この様に圧縮弾性材料Aを各面間に配することにより、熱応力が緩和され、ハニカム構造体の耐久性がさらに向上する。

【0024】本発明において、圧縮弾性材料Aは耐熱性とクッショニング性を備えることが好ましい。耐熱性及びクッショニング性を有する圧縮弾性材料Aとしては、バーミュキュライトを実質上含まない非膨脹性材料、又は少量のバーミュキュライトを含む低膨脹性材料であり、アル

ミナ、高アルミナ、ムライト、炭化珪素、窒化珪素、ジルコニア、チタニアからなる群より選ばれた少なくとも1種あるいはそれらの複合物からなるセラミック繊維を主成分とすることが好ましく、この中でもバーミュキュライトを実質上含まずアルミナ又はムライトを主成分とする非膨脹性材料がより好ましい。さらに、これらの繊維製マットであることが好ましく、セラミック繊維製マットがアルミナ又はムライト組成を主成分とする非膨脹性マットであることがさらに好ましい。これらのセラミック製マットは、被処理流体の漏れを防止する観点からシール性を有することがさらに好ましい。圧縮弾性材料Aの好適な具体例は、3M社製/1100HTや三菱化学社製/マフテック等である。

【0025】本発明において、ハニカムセグメント2は強度、耐熱性等の観点から、主成分が、炭化珪素、窒化珪素、コーチェライト、アルミナ、ムライト、ジルコニア、磷酸ジルコニウム、アルミニウムチタネート、チタニア及びこれらの組み合わせよりなる群から選ばれる少なくとも1種のセラミックス、Fe-Cr-Al系金属、ニッケル系金属又は金属SiとSiCとかなることが好ましい。本発明において、主成分とは成分の80質量%以上を占め、主結晶相となるものを意味する。接合材7も上記ハニカムセグメントに好適な材料の中から選ぶことができる。

【0026】圧縮弾性材料Aを配する際には、製作上の観点から、ハニカムセグメント2の断面は、少なくとも一辺が、30mm以上であることが好ましく、さらに好ましくは50mm以上、最も好ましくは70mm以上である。

【0027】図3は図1に示すハニカム構造体を金属容器11に保持したハニカム構造体アッセンブリ8の断面-模式図である。図3に示す本発明のハニカム構造体アッセンブリ8は、ハニカム構造体1の最外周面23に圧縮弾性材料B5を圧縮状態で配することによりハニカム構造体1を金属容器11に圧縮把持してなるものである。

【0028】本発明において圧縮弾性材料B5としては、前述の圧縮弾性材料Aと同様に耐熱性及びクッショニング性を有することが好ましく、さらにシール性を有することが好ましいが、非膨脹性材料であっても膨脅性材料であっても良い。好ましい圧縮弾性材料Bはアルミナ、高アルミナ、ムライト、炭化珪素、窒化珪素、ジルコニア、チタニアからなる群より選ばれた少なくとも1種あるいはそれらの複合物を主成分とするセラミック繊維等であるが、これらの繊維製マットであることがさらに好ましい。具体的には前述の3M社製/1100HTや三菱化学社製/マフテック等を用いることができるが、膨脅性マットである3M社製/インタラムマット等を用いることもできる。

【0029】本発明において、ハニカム構造体1を圧

縮弾性材料Bとともに圧縮状態で金属容器11内に入れることは、図4に示すガイド17を用いた押込み方法、図5に示す金属板11cを巻き付けて引っ張ることで面圧を付与し、金属板11cの合わせ部を溶接して固定する巻き絞め方法、あるいは図6に示す2分割された金属容器11a、11bで負荷を与えながら挟み込み、2つの金属容器11a、11bの合わせ面(つば)16a、16bの個所を溶接することで一体化容器とするクラムシェル方法が好適である。また、この他に、図7に示すような、金属塑性加工技術を応用した、金属容器11を外部からタップ(加圧型)12を介して圧縮圧力を加えて金属容器11の外径寸法を絞る方法(スウェーリング方法)も好適である。さらには、図8に示すように、塑性加工を応用した方法で金属容器11を回転させながら加工治具18を用いて最外周面を塑性加工により絞り込む方法、いわゆる回転鍛造方法によることで金属容器の外径を絞り、面圧を付与する方法も可能である。

**【0030】** 本発明のハニカム構造体又はハニカム構造体アッセンブリを触媒担体として、内燃機関、ボイラ、化学反応機器、燃料電池用改質器等に用いる場合、ハニカムセグメントに触媒能を有する金属を担持させるようとする。触媒能を有する代表的なものとしてはPt、Pd、Rh等が挙げられ、これらのうちの少なくとも1種をハニカムセグメントに担持させることが好ましい。

**【0031】** 一方、本発明のハニカム構造体又はハニカム構造体アッセンブリを、ディーゼルエンジン用パティキュレートフィルター(DPF)のような、排気ガス中に含まれる粒子状物質を捕集除去するためのフィルターに用いようとする場合、ハニカム構造体の流通孔を交互に封じ隔壁をフィルターとする構造を有するものが好ましい。

**【0032】** このような、ハニカムセグメントから構成されるハニカム構造体の一端面より粒子状物質を含んだ排気ガスを通すと、排気ガスは当該一端面側の流通孔が封じられていない流通孔よりハニカム構造体の内部に流入し、渦過能を有する多孔質の隔壁を通過し、他端面側の封じられていない孔より排出される。この隔壁を通過する際に粒子状物質が隔壁に捕捉される。端面を封じるための材料は上記ハニカムセグメント2に好適な材料の中から選ぶことができる。

**【0033】** なお、捕捉された粒子状物質が隔壁上に堆積してくると、圧損が急激に上昇し、エンジンに負荷がかかり、燃費、ドライバビリティが低下するので、定期的にヒーター等の加熱手段により、粒子状物質を燃焼除去し、フィルター機能を再生させるようとする。この燃焼再生時、燃焼を促進させるため、ハニカム構造体に前記のような触媒能を有する金属を担持させても良い。

**【0034】** 本発明において、ハニカム構造体又はハニカム構造体アッセンブリに触媒を担持させる方法とし

ては、触媒担持前に金属容器11内にセルハニカム構造体1を持してから、ハニカム構造体1に触媒を担持させる方法が可能である。この方法によれば、触媒担持工程中に、ハニカム構造体1が欠けたり、破損したりする可能性を回避することができる。また、ハニカムセグメント2に触媒成分を担持した後に、ハニカム構造体1とし、これを金属容器11内に収納把持してなることが、本発明のハニカム構造体又はハニカム構造体アッセンブリを触媒コンバータとして用いる場合に好ましい。

#### 【0035】

**【実施例】** 以下、本発明を実施例に基づいてさらに詳細に説明するが、本発明はこれらの実施例に限定されるものではない。尚、以下の実施例及び比較例で作製したハニカム構造体はセルを交互に目封じし、隔壁をフィルターとして利用するディーゼル微粒子捕集用フィルターである。

**【0036】** (実施例1) 原料として、炭化珪素粉末を使用し、これにメチルセルロース及びヒドロキシプロポキシルメチセルロース、界面活性剤及び水を添加して、可塑性の坏土を作製した。この坏土を押出成形し、マイクロ波及び熱風で乾燥した。次いで、端面を交互に千鳥状になるようにハニカム構造体と同材質の目封止材で目封止し、次に、N<sub>2</sub>雰囲気中で加熱脱脂した後、Ar雰囲気中で焼成して、外径がΦ144mm、内径がΦ73mmの1/4断面形状×長さ152mmの外側セグメント2b、及び外径がΦ72mmの1/2の断面形状×長さ152mmの内側セグメント2aを得た。内側セグメント2aの壁厚は0.38mm、セル密度が31セル/cm<sup>2</sup>であり、外側セグメント2bの壁厚は0.25mm、セル密度が31セル/cm<sup>2</sup>である。これらのハニカムセグメントをコロイダルシリカとアルミナファイバーを水で混合した接合材により接合、乾燥することにより、直径144mm×長さ152mm、の円柱状ハニカム構造体1が組み立てられた。さらに、そのハニカム構造体1の外周にセラミック繊維製非膨脹マットを巻き付け、SUS409の金属容器11にテーパー治具により押込んでセグメント間、ハニカム構造体1と金属容器11間を圧縮固定してハニカム構造体アッセンブリ8を得た。

**【0037】** (実施例2) 実施例1と同様の操作を行い、内側セグメント2aの壁厚が0.38mm、セル密度が31セル/cm<sup>2</sup>であり、外側セグメント2bの壁厚が0.25mm、セル密度が47セル/cm<sup>2</sup>であるハニカム構造体1を得た。さらに、そのハニカム構造体1の外周にセラミック繊維製非膨脅マットを巻き付け、SUS409の金属容器11にテーパー治具により押込んでセグメント間、ハニカム構造体1と金属容器11間を圧縮固定してハニカム構造体アッセンブリ8を得た。

**【0038】** (実施例3) 実施例1と同様の操作を行い、内側セグメント2aの壁厚が0.43mm、セル密

度が31セル/cm<sup>2</sup>であり、外側セグメント2bの壁厚が0.20mm、セル密度が47セル/cm<sup>2</sup>であるハニカム構造体1を得た。さらに、そのハニカム構造体1の外周にセラミック繊維製非膨脹マットを巻き付け、SUS409の金属容器11にテーパー治具により押込んでセグメント間、ハニカム構造体1と金属容器11間を圧縮固定してハニカム構造体アッセンブリ8を得た。

【0039】(実施例4)実施例1と同様の操作を行い、内側セグメント2aの壁厚が0.53mm、セル密度が16セル/cm<sup>2</sup>であり、外側セグメント2bの壁厚が0.20mm、セル密度が62セル/cm<sup>2</sup>であるハニカム構造体1を得た。さらに、そのハニカム構造体1の外周にセラミック繊維製非膨脹マットを巻き付け、SUS409の金属容器11にテーパー治具により押込んでセグメント間、ハニカム構造体1と金属容器11間を圧縮固定してハニカム構造体アッセンブリ8を得た。

【0040】(比較例1)実施例1と同様の操作を行い、内側及び外側の全セグメントの壁厚が0.38mm、セル密度が31セル/cm<sup>2</sup>であるハニカム構造体1を得た。さらに、そのハニカム構造体1の外周にセラミック繊維製非膨脅マットを巻き付け、SUS409の金属容器にテーパー治具により押込んでセグメント間、ハニカム構造体1と金属容器11間を圧縮固定してハニカム構造体アッセンブリ8を得た。

【0041】(ストート堆積圧力損失試験)このようにして得た実施例1~4及び比較例1のハニカム構造フィルター(ハニカム構造体アッセンブリ)に、ディーゼルエンジンから排出される微粒子(以降ストートと称する)を含んだ、排ガス温度200°C、排ガス流量2.4Nm<sup>3</sup>/min.の排気ガスを通して、ハニカム構造フィルターに4gのストートが堆積した時の圧力損失を測定した。試験結果を図9に示す。比較例1のフィルターに4gのストートを堆積させた時の圧損は9.0KPaであった。これに比べ外側セグメントの壁厚を薄くした実施例1のフィルターは6.7KPaと比較例に比べ26%低かった。実施例1と同じ壁厚とし、外側セグメントのセル密度を大きくした実施例2では6.2KPaの圧損を示し、比較例に比べ31%とさらに低圧損であった。さらに、ハニカム構造体に働く熱応力をより低減する目的で、内側セグメントの壁厚を厚く、熱容量を大きくした、圧損に不利な実施例3及び実施例4のフィルターでも、外側セグメントの壁厚をさらに薄く、セル密度をさらに大きくすることで、実施例3のフィルターで5.9KPaの圧損、実施例4のフィルターで6.0KPaの圧損とそれぞれ比較例に比べ34%、33%と十分低い圧損を可能とした。

【0042】(燃焼再生試験)実施例3、4及び比較例1のハニカム構造フィルターにストートを各々30g捕集し、入口ガス温700°C、酸素濃度10%、排ガス流量0.7Nm<sup>3</sup>/min.の排気ガスによりフィルター

に堆積したストートを燃焼、ハニカム構造体内15箇所の温度を測定した。燃焼試験後、ハニカム構造フィルターの重量を測定し、ストートの再生効率を求めた。さらに、燃焼再生によるハニカム構造体の損傷を目視と実体顕微鏡により観察、破損の有無を確認した。

【0043】比較例1のフィルターのハニカム構造体内最高温度は1050°Cまで上昇し、ハニカム構造体は破損した。これに対し、本発明による実施例3及び4のフィルターは、最大温度が各々830°C及び780°Cと低く抑えられ、ストート再生効率も90%以上を示した。

【0044】

【発明の効果】以上説明してきたように本発明によるハニカム構造体及びそのアッセンブリは、内側セグメントの壁厚を外側セグメントの壁厚より厚くし、外側セグメントの壁厚を内側セグメントの壁厚より薄く、且つセル密度を大きくすることにより、隔壁の有効気孔率を大きく、フィルタ一面積を大きくできるので、ディーゼル微粒子堆積時の圧力損失が低く、且つハニカム構造体内に発生する最大温度が低く抑えられ、ストート再生効率を高く保つものとなった。従って、本発明によるハニカム構造体及びそのアッセンブリは、圧力損失が低く、且つ優れた耐久性及び高い効率を示した。

【図面の簡単な説明】

【図1】(a)は本発明の一実施形態を示すハニカム構造体の断面一模式図であり、(b)、(c)は(a)における各々内側セグメント及び外側セグメントの拡大図である。

【図2】本発明の別の実施形態を示すハニカム構造体の断面一模式図である。

【図3】本発明の一実施形態を示すハニカム構造体アッセンブリの断面一模式図である。

【図4】金属容器内へのハニカム構造体の押込み方法の一例を示す一部切り欠き説明図である。

【図5】金属容器内へハニカム構造体を収納するための巻き絞め方法の一例を示す斜視図である。

【図6】金属容器内へハニカム構造体を収納するためのクラムシェル方法の一例を示す斜視図である。

【図7】金属容器内へハニカム構造体を収納するためのスウェーリング方法の一例を示す流通孔方向に対する平行断面図である。

【図8】金属容器内へハニカム構造体を収納するためのスウェーリング方法の一例を示す流通孔方向に対する平行断面図である。

【図9】ストート堆積圧力損失試験の結果を示すグラフである。

【図10】ストート燃焼再生試験の結果を示すグラフである。

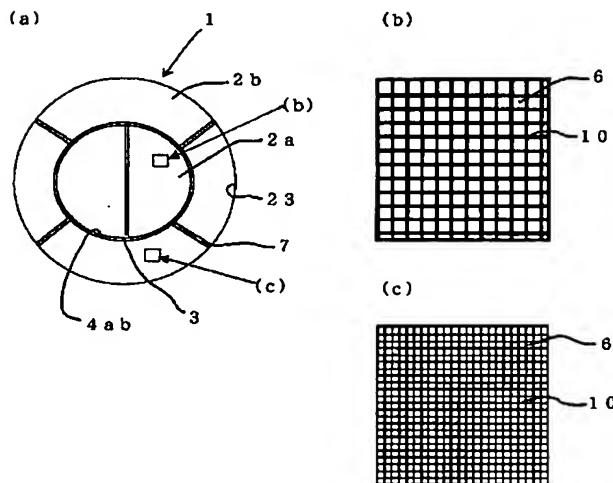
【符号の説明】

1…ハニカム構造体、2…ハニカムセグメント、3…圧縮弾性材料A、4…ハニカムセグメントが互いに隣接す

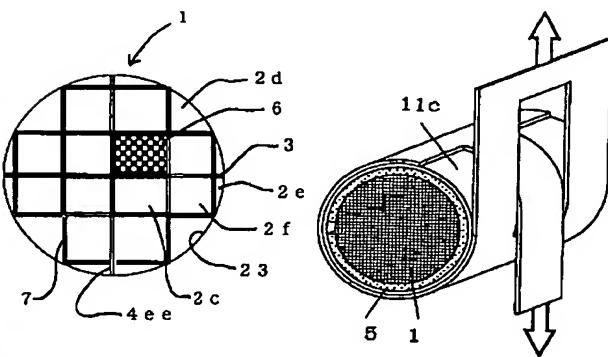
る面、5…圧縮弾性材料B、6…流通孔、7…接合材、8…ハニカム構造体アッセンブリ、10…隔壁、11…金属容器、11a、11b…分割金属容器、11c…金

属板、12…タップ（加圧型）、16a、16b…2つの金属容器の合わせ面（つば）、17…ガイド、18…加工治具、23…ハニカム構造体の最外周面。

【図1】

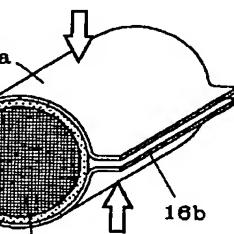


【図2】

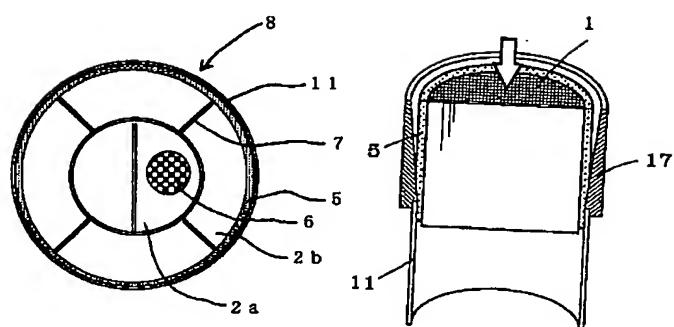


【図5】

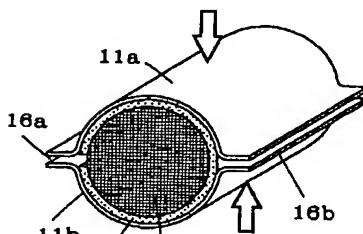
【図6】



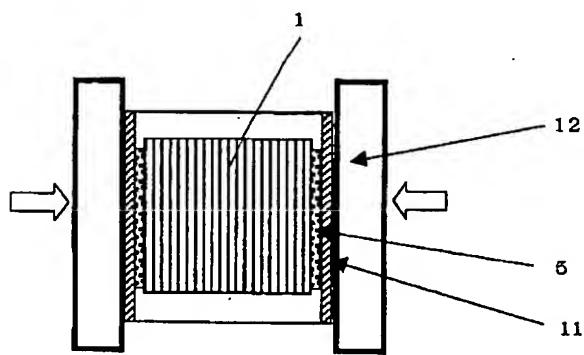
【図3】



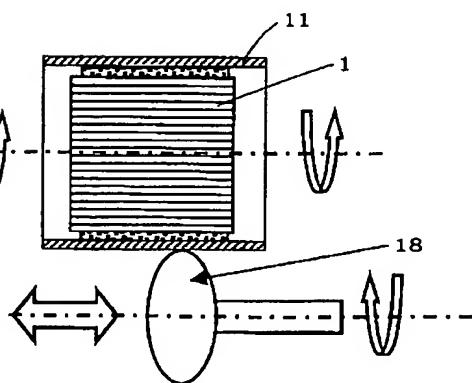
【図4】



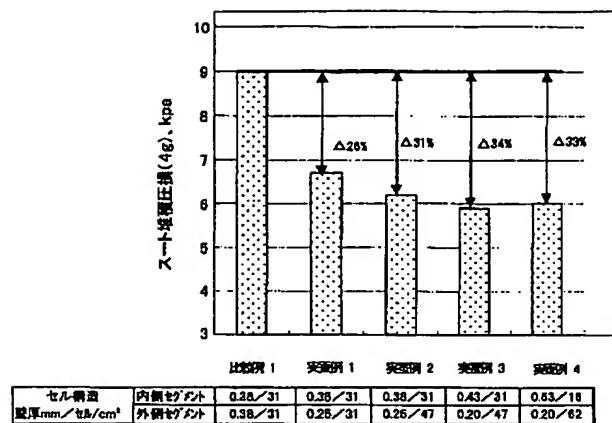
【図7】



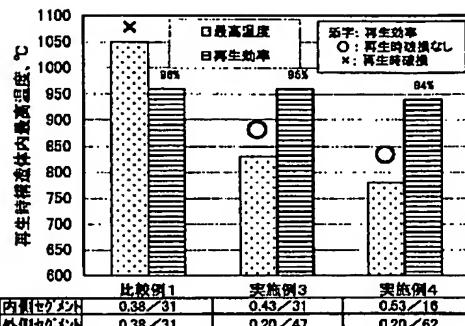
【図8】



【図9】



【図10】



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